hypothesis of electrolytic dissociation. At first sight one is shocked by being told that a very strong acid such as nitric acid, or a very strong base such as potash, is dissociated in aqueous solution, to perhaps 90 per cent., into its ions ; in the case of potash, one remarks that the ions must be potassium and the group OH, and that each of these bodies reacts with water the moment they are brought into contact. To meet these objections, Ostwald reminds us that a chemically energetic compound is one which readily suffers chemical change, and the parts of which are therefore readily separated ; and he remarks that the *ion* potassium is not the same thing as ordinary potassium ; the ion holds a large electric charge ; when it comes to the electrode it gives up this charge, and *then*, but not till then, it reacts with water. But difficulties still remain : one of the greatest is to explain the mode of action of the solvent. Does the solvent merely form a medium in which the separate ions move about? Why then does increase of solvent increase the amount of dissociation? May not the solvent react with the dissolved body to form complex molecular aggregates which then dissociate into simpler ions? Is the dissolved body the electrolyte, or is the electrolyte a compound, or aggregate, made up of the dissolved body and the solvent? Is the electrolyte actually separated into its ions in the solution, or does it only exhibit an "aptitude for directed dissociation"? These questions, and questions such as these, have yet to be answered.

The hypothesis of electrolytic dissociation has been worked out in detail in several directions, by Arrhenius and Ostwald, and has been found to give results in keeping with experiment. In considering its application to explain chemical change between electrolytes—for it really presents a theory of chemical changes between electrolytes—it is necessary to remember that, in its present form at any rate, it is applicable only to substances in aqueous solution. Because a solution of hydrochloric acid is very chemically active, it does not follow that liquid HCl should also be chemically energetic ; nor, because gaseous HCl is not dissociated by heating to a fairly high temperature, does it follow that an aqueous solution of this compound should not be largely dissociated into the ions hydrogen and chlorine.

The hypothesis of chemical change between electrolytes in solution, which is based on van 't Hoff's extension of the law of Avogadro to substances in dilute solutions, and on the general close agreement between such dilute solutions and gases, cannot yet be finally accepted or rejected by chemists. It has already done much to draw closer the connexions between chemical and electrical phenomena, it has gone further than any other hypothesis of chemical change in helping forward the solution of the main problem of chemists, and it has opened up many new lines of advance.

There is one general conclusion to be come to from the study of all the recent work on chemical affinity : I think we may agree with Ostwald when he says that Bergmann was certainly right in assigning a definite affinity to each element and compound, and that Berthollet was right in asserting that affinity is modified by the relative masses of the reacting bodies, but that Bergmann erred in saying that chemical change always occurs in one direction only and that the direction of the strongest affinities, while Berthollet also erred in regarding the affinity between acids and bases as inversely proportional to the equivalent weights of the reacting compounds. Bergmann's error has been revived in modern times ; it has now assumed a physico-chemical aspect ; it finds its expression in Berthelot's so-called *law of maximum work*, which asserts that every chemical change accomplished without the addition of energy from without tends to the formation of that body or system of bodies the production of which is accompanied by the development of the maximum quantity of heat. In so far as this statement can be translated into precise terms it can be proved to be dynamically unsound. When applied to chemical reactions, it tells us that of several possible reactions that one which is accompanied by the production of the greatest quantity of heat occurs to the exclusion of others ; but this has again and again been experimentally disproved.

M. M. PATTISON MUIR.

THE PASTEUR INSTITUTE.

LAST week the Lord Mayor received a letter from M. Pasteur, acknowledging receipt of the resolutions passed at the recent Mansion House meeting. In this letter M. Pasteur writes :—

"If the aphorism that science has no country has never received authoritative sanction, it did so at this meeting, in which the leading *savants* in biological and medical science of the United Kingdom took part. I wish I could thank them individually for having attended this gathering. I was filled with gratitude on learning that the Prince of Wales himself had accorded his high approbation of your initiative. Modesty compels me to pass over in silence the kind words of which my labours and those of the Pasteur Institute have been the subject, but I have a right to rejoice with all friends of the progress of humanity at the great moral effect of the meeting. The manifestation of July 1 had not only for its object the question of the treatment and possible extinction of hydrophobia in England, but in the nature of things it was also a protest against that false sentimentality which led certain persons, not—which was already a strong point with them—merely to put on the same footing the life of men and that of animals, but even to prefer the existence of animals to the salvation of human life. When this view is taken, what is the limit? We must become firm vegetarians. We must even extend our scruples so that no living being is sacrificed. We must endure the importunities of a mosquito, the daring of a mouse, the stings of a flea—false ideas or excuses for a tirade which one finds is most often at the bottom of all the attacks on experimental physiology. Certain credulous souls—by I know not what tales—imagine that our laboratories are chambers of torture. They ignore the fact that the rabbit or the guinea pig is rendered insensible by chloroform before it is subjected to the most insignificant operation. As for me personally, the suffering of an animal affects me so much that I would never shoot a bird, and the cry of a wounded skylark pierces me to the heart ; but if the investigation of the mysteries of Nature and the acquisition of new truths be at stake, the sovereignty of the object justifies all. Who, then, having the least regard for the pursuit of the knowledge of the mysteries of Nature, would put in the balance the sacrifice of a few fowls and rabbits with the discovery of the attenuation of virus and prophylactics which have resulted from such sacrifice? No one, my Lord Mayor, will have contributed more than you have done to rectify the errors which under a show of compassion can only hinder the progress of science and compromise even the most legitimate interests of humanity."

THE TERRESTRIAL GLOBE AT THE PARIS EXHIBITION.

SOME time before the opening of the Paris Exhibition it was announced that one of the attractions of the show would be a great terrestrial globe, one millionth of the actual size of the earth. This globe is now exhibited in a building specially erected, near the Eiffel Tower, for the purpose, and it excites the warmest interest among all visitors who have devoted the slightest attention to geographical science. It was designed by MM. Villard and Cotard, and these gentlemen, who have received many congratulations on their success, have lately issued an account of the manner in which their project has been realized.

Maps on a plane surface give, of cause, a very inadequate impression of the real appearance of our planet; and ordinary globes are too small to indicate, even vaguely, the extent of the spaces represented on them. The idea of making a globe one millionth of the size of the earth deserves, therefore, to be described as a "happy thought," for, although the meaning of a million may not be fully appreciated, it is not absolutely inaccessible to the human mind. When we see a place or a district marked on a globe, and learn that the reality is a million times larger, the proportions are impressively suggested, with at least some approach to accuracy.

The diameter of the globe constructed by MM. Villard and Cotard is 12·73 metres. It has a circumference of 40 metres, and a millimetre of its surface represents a kilometre. The globe consists of an iron framework made chiefly of meridians united to a central core. This structure is carried by a pivot resting on an iron support. To the meridians pieces of wood are attached, and on these are fixed the panels composing the surface of the globe. These panels are made of sheets of cardboard bent by hand to the required spherical shape, and covered with plaster specially hardened. Fig. 1[1] shows how they are applied to the underlying structure. The total surface is divided into forty spindle-shaped spaces, the breadth of each of which at the equator is exactly one metre. Each "spindle" is itself subdivided, so that there are 600 panels of various dimensions. The designs are painted on the panels before they are put in their place, in order that the globe may ultimately be easily dismantled and removed.

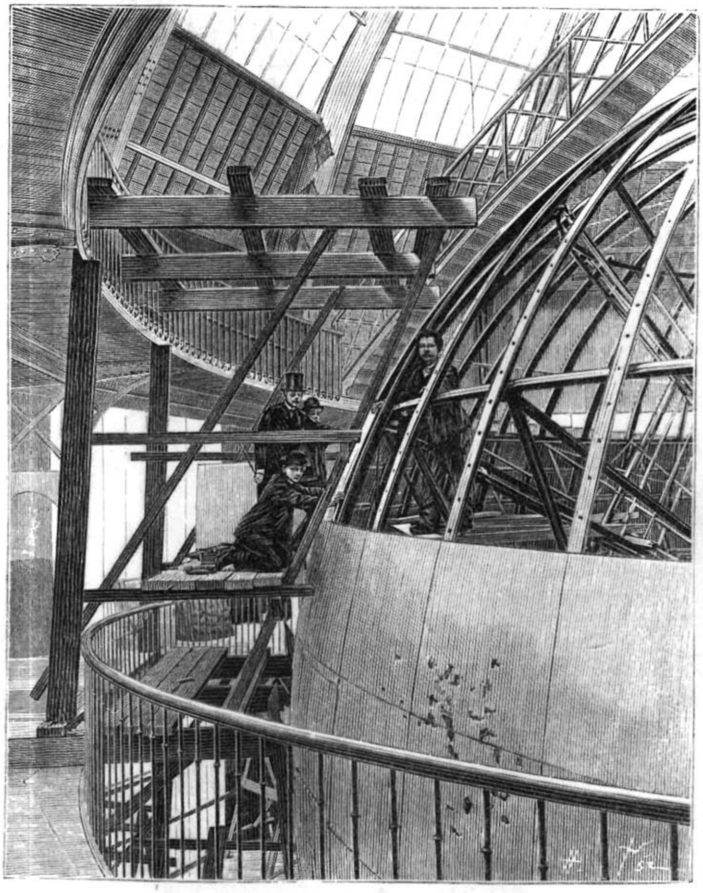

Fig. 1.

The edifice in which the globe is shown has a metallic framework forming a cupola. It is lighted from above, and by the great glass frames of the sides. From a terrace or narrow foot-bridge at the upper part the visitor can see the polar and temperate regions of the northern hemisphere. As he descends, he is able to see in succession all the regions of the globe to the south pole. At the bottom he comes to the support of the globe with the apparatus for putting it in motion (Fig. 2).

Even the loftiest mountains, if shown in relief, could only have been represented by elevations a few millimetres in height. Consequently the various mountain ranges have been painted on the surface. The various depths of the ocean are indicated in a similar manner.

To facilitate the study of the globe, it has been mounted with its axis vertical, and it may be turned upon the pivot which carries it. If its rotation were made to equal that of the earth, at its equator, a point of its surface would move at the rate of half a millimetre in the second. This movement would scarcely be visible, but it would, of course, represent an actual movement of the earth over half a kilometre in the same time.

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[1] We are indebted to the editor of *La Nature* for the figures here reproduced.

A figure of the moon, corresponding to this one of the earth, would have a diameter of 3·50 metres, and would be 384 metres distant. A like figure of the sun would have a diameter of 1400 metres, and be distant about 150 kilometres. The diameter of a globe representing Jupiter on the same scale would be one-half, that of a globe representing Saturn on the same scale would be a little more than one-third, of the height of the Eiffel Tower.

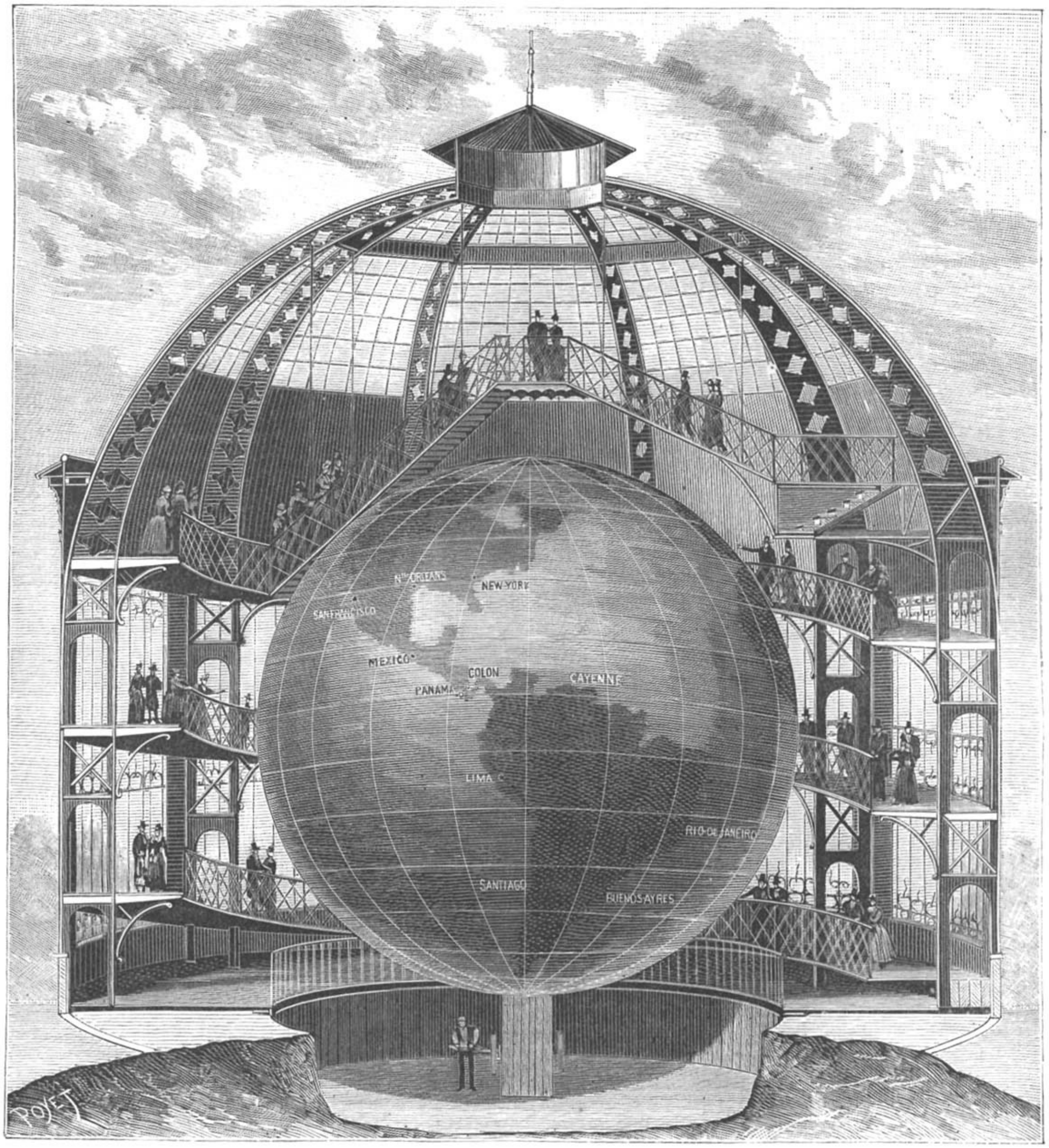

FIG. 2.

This is not the first occasion on which an attempt has been made to suggest by means of a great globe the size of the earth, and the extent of its oceans and land-masses. The globe of the Château of Marly, which is still to be seen in the National Library of Paris, excited much admiration in the age of Louis XIV., but it has only a diameter of about 5 metres, and is much less effective for its purpose than its successor in the Paris Exhibition.

It is significant of the present stage of our knowledge of the interior of Africa that the makers of the globe, in preparing their maps, had twice to alter their representation of that continent in order to indicate the results of the most recent geographical discoveries.